MATHEMATICAL NOTATION

THE HALIFAX CODE

Written by the Late Dr. S. R. Hussey (1933)

Revised by

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Transcribed into print by Daniel Harmer

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H 228

Preface

This is the second edition in print of Dr. S. R. Hussey's code, which he wrote in braille in 1933. Dr. Hussey (1874-1964) was born in Newfoundland, Canada. He lost his sight through scarlet fever in 1887 and attended Sir Frederick Fraser School, then named Halifax School for the Blind, in Nova Scotia, Canada. He graduated in 1893 and was principal of Sir Frederick Fraser School from 1923 to 1950.

This edition updates his work where necessary, while retaining as much of his original text as possible. The objectives Dr. Hussey set out to achieve, i.e., simplification, the saving of space and the use of the minimum number of symbols, has been maintained in this second print edition.

We wish to thank other members of the staff of Sir Frederick Fraser School for their assistance in this revision, and to mention in particular Judith Johnson (mathematics teacher) and Maxine Tucker (braille transcriber). Also, we wish to thank Richard Sutherland, mathematics associate professor of Dalhousie University and Margaret Williams for her recommendations with respect to format.

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Halifax, Nova Scotia
March, 1981

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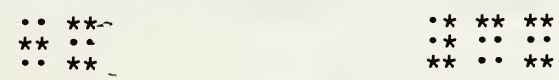
MATHEMATICAL NOTATION

THE HALIFAX CODE

"The main object of this system is simplification, the saving of space, and above all the avoidance to the young mind, of unfamiliar symbols". This is contained in the opening paragraph of Dr. S. R. Hussey's original edition of this code.

To achieve this, two important steps are necessary in the Halifax Code. First, arabic figures representing whole numbers are dropped to the lower register and are read as numeral coefficients without the number sign.

Example 1. 3 X instead of # 3 X



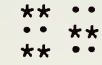
Note:- This is a saving in space of 33 1/3%.

Example 2. 3 A B instead of # 3 × A B

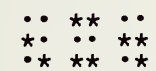
Note:- This is a saving in space of 40%.

Second, since, in print, the exponent is written above the character to which it refers, and, since in braille this is impossible, arabic figures are dropped to the lower register again and are read as exponents without the use of the number sign.

Example 1. X^{3}



Example 2. $5X^{4}$



Notice that this requires the convention of numbers appearing before letters to be strictly followed.

Further, distinction is made between mathematical expressions and non-mathematical ones. Braille symbols may have different meanings in these two circumstances. Typically, when a print expression contains a verb, numbers are preceded by a number sign and written in the upper register. When there is no verb, numbers are written in the lower register, and the number sign takes on a new meaning as shown below.

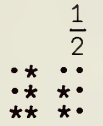
When a mathematical expression is included in a print sentence, it may be enclosed in mathematical brackets and then be written using lower register numbers.

For students just starting an academic curriculum, a modification to this code is recommended up to the Grade 3 level. This is described in Appendix II.

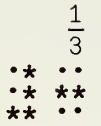
Fraction indicator ⠨

Examples:-

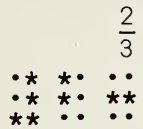
1. $\frac{1}{2}$



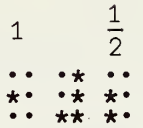
2. $\frac{1}{3}$



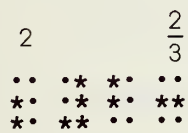
3. $\frac{2}{3}$



4. $1\frac{1}{2}$

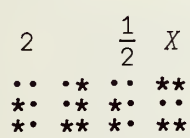


5. $2\frac{2}{3}$

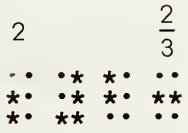


6. $2X$

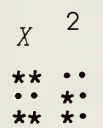
7. $2\frac{1}{2}X$



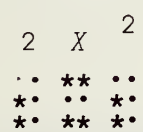
8. $2\frac{2}{3}X$



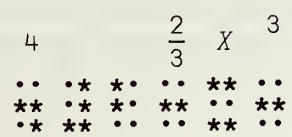
9. X^2



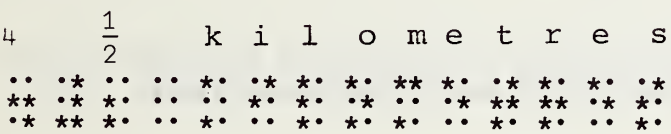
10. $2X^2$



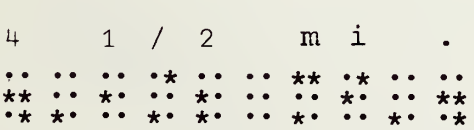
11. $4\frac{2}{3}X^3$



12. 4 $\frac{1}{2}$ kilometres



13. 4 1/2 mi.



Dot 3, in the last example, separates the integral part of the mixed number from the fractional part. Dot 3 is always used to separate a punctuation mark from an algebraic expression.

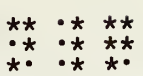
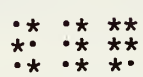
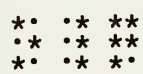
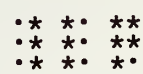
No space is to be left either before or after an operational sign.

+	plus	
-	minus	
±	plus or minus	
∓	minus or plus	
× or ·	multiplied by	
/ or ÷	over or fraction line, divided by	
÷	divided by (used with fractions)	
⟌	divided into	
:	ratio	

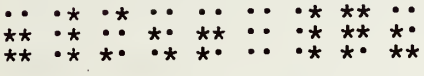
The student just starting to master mathematics may have difficulty recognizing the difference between a "+" and a "2"

The following signs all require a space before them to prevent possible misinterpretations.

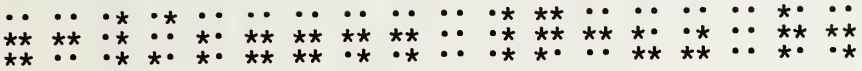
SIGNS OF OPERATION

=	is equal to	
≠	is not equal to	
<	is less than	
≮	is not less than	
>	is greater than	
≯	is not greater than	
≤	is less than or equal to	
≥	is greater than or equal to	
::	as (used in ratios)	
≈ ~ ≒	is approximately equal to	
≡	is identically equal to	

1. 7 ⟌56 = 8

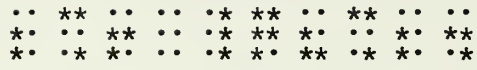


2. 73 ⟌2774 = 380 R 4



3. 6 : 7

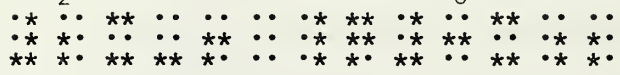
4. 2 : 6 = 8 : 2 4



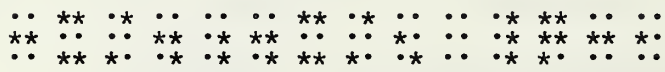
5. 2 : 6 as 8 : 2 4

6. 3 x + 5 = 3 2

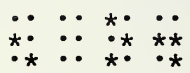
7. $\frac{1}{2}$ x - 6 = $\frac{1}{3}$ x + 2



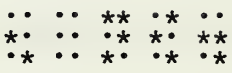
8. 3 x / 4 + 4 x / 5 = 3 1



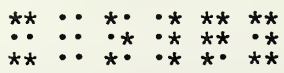
9. 5 > 4



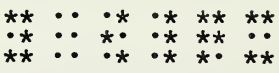
10. 5 ≠ 4



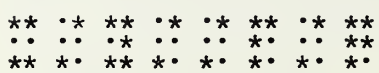
11. x ≥ y



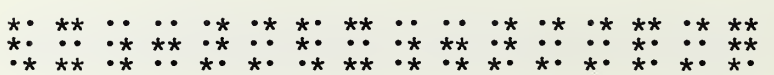
12. y ≤ x



13. x / y ÷ p / q



14. (x + 3) / (x + 4) ÷ p / q

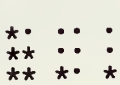


SIGNS OF OPERATION

(...) parenthesis or round brackets

{...} brackets or curly brackets

[...] square brackets



additional brackets or matrices

|...| absolute value of or determinants

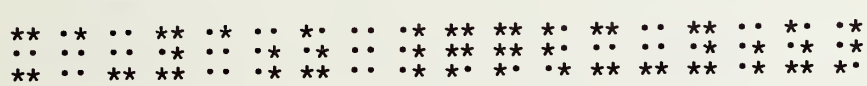
——
...
vinculum
(This form of bracket is rarely used)

limiting sign
(See examples for use. It is used to show that terms to the left of it are to be included as though a bracket were used. Designated in print as "L")

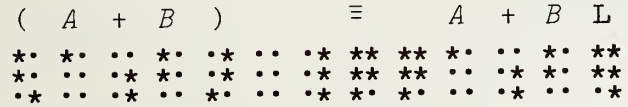
Examples:-

1. (3 + 4) { (4 + 5) - 3 } = 4 2

2. $\overline{X - Y + Z} \equiv (X - Y + Z)$

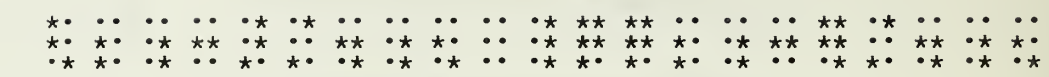


3. (A + B) $\equiv$ A + B L



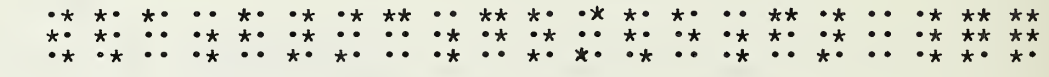
4. (A + B) / (C - D) $\equiv$ A + B L / C - D $\bar{\text{L}}$

5. (2 + 3) / 4 + 5 ≡ 2 + 3 L / 4 + 5

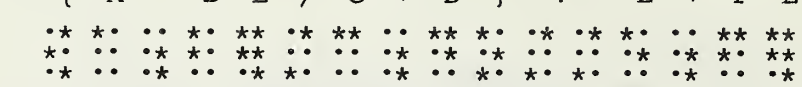


Note that the example above is the same as $\frac{2+3}{4} + 5$ in print. The use of the limit sign, L, is particularly useful when using dictation and the opening brackets are omitted.

6. { (A + B) / C + D } / (E + F) ≡

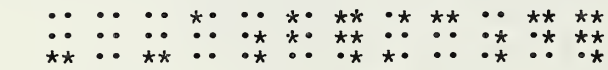


{ A + B L / C + D } ÷ E + F L



In print this example might be shown as $\left\{\frac{A+B}{C} + D\right\} \div (E+F)$

7. - - A + B L / C + D L (= $-\frac{-A+B}{C+D}$)

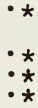


Note that the space ends the limiting sign's effectiveness.

a. Decimals

decimal

repeating decimal



Examples:-

1. . 1 5

2. 3 . 1 5

3. 3 . 3 (3.3 or 3.$\dot{3}$ or 3.3333....)

4. 3 . 8 1 4 7 (3.8147 or 3.8$\dot{1}\dot{4}\dot{7}$ or 3.8147147...)

b. Common abbreviations

$	dollar(s)		%	percent	
¢	cent(s)		°	degree	
m	metre(s)		'	minutes	
'	foot (feet)		''	seconds	

Note: Use metric abbreviations as in print.

Rules for usage:-

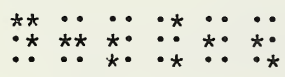
1. Use the standard inkprint abbreviations, noting that the $ symbol comes before the number and the other symbols come after the numbers as in print.

2. In mathematics, use lower register numerals and no space, with the exception that the % sign must be preceded by dot 3.

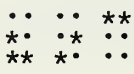
3. In sentences, use the number sign and the upper register numbers. In all cases except the $ sign and in continuing expressions such as 45° 30', dot 3 is required between the number and the abbreviation.

Examples:-

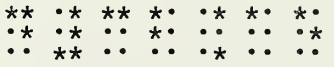
1. $ 3 2 . 1 5



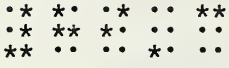
2. 8 9 ¢



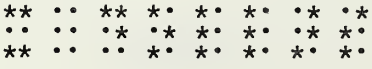
3. $ 3 2 . 1 5 (in a sentence - $32.15)



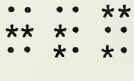
4. 8 9 ¢ (in a sentence - 89¢)



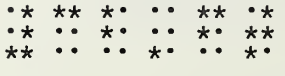
5 x d o l l ar s ($x)



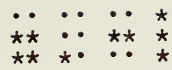
6. 3 2 m



7. 3 2 f t (in a sentence - 32ft)

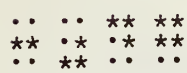


8. 7 %



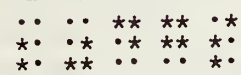
9. 7 % (in a sentence - 7%)

10. 3 0 ° (30°)



11. 4 5 ' (45')

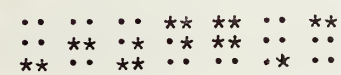
12. 2 0 " (20")



13. 2 0 ° 4 5 ' 2 0 "

14. 3 0 ° 4 5 ' (in a sentence - 30°45')

15. - 3 0 ° C

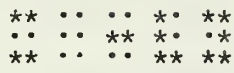


c. Symbols

#	number sign		,	mathematical comma	
$\propto$	varies as or proportional to		!	factorial	
∞	infinity			difference between	
Σ	sum			base indicator	
Σ^{∞}	sum to infinity				

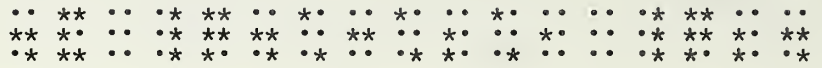
Examples:-

1. x × y



2. x (y + z) ≡ x y + x z

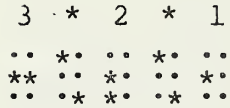
3. 4 ! = 4 * 3 * 2 * 1 = 2 4



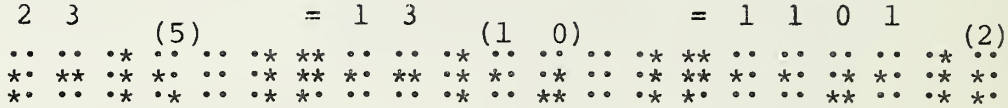
4. r ! s ! = r (r - 1) (r - 2) (. . .) *

3 * 2 * 1 * s (s - 1) (s - 2) (. . .) *

3 * 2 * 1



5. $23_{(5)} = 13_{(10)} = 1101_{(2)}$



This is shown in print as $23_{(5)} = 13_{(10)} = 1101_{(2)}$

root sign

root indicator

(L) limiting sign

A number or an expression preceding a root sign is a multiplier of that root. A number or expression before the root sign, but preceded by the root indicator is a root. The limit sign (L) is used to show that the root sign includes every number or expression up to the limit sign, unless brackets are used.

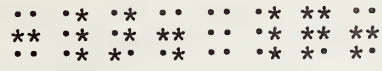
Examples:-

1. √4 9 L = 7 ($\sqrt{49} = 7$)

2. √x

3. √(x y) ≡ √x y L

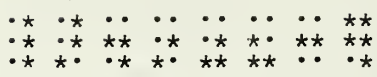
4. 3 √4 = 6



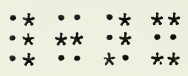
5. (p + q) √(x + y) =

(p + q) √x + y L

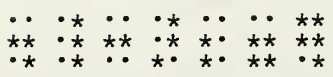
6. $\sqrt{49083}$ L



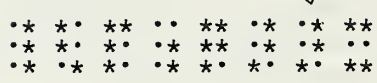
7. $\sqrt[3]{x}$



8. $4\sqrt[3]{27}$ L ($= 4\sqrt[3]{27}$)

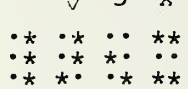


9. $(p+q)\sqrt{x}$ ($= \sqrt[(p+q)]{x}$)

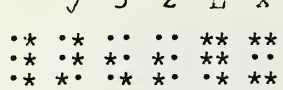


Note that in the above examples, there are no numerals and letters combined. An additional rule is required for these, which states that the root sign only affects the positive arabic number or letter immediately following it. If the root sign affects more than one number or letter, the limiting sign (L) is used.

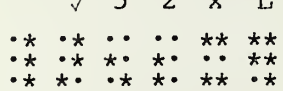
10. $\sqrt{5x}$ ($=\sqrt{5}x$)



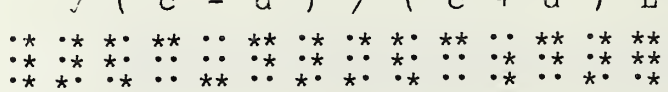
11. $\sqrt{52}x$ ($=\sqrt{52}\,x$)



12. $\sqrt{52x}$ ($=\sqrt{52x}$)



13. $\sqrt{(c-d)/(c+d)}$ L ($=\sqrt{\frac{c-d}{c+d}}$)



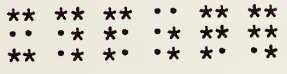
EXPONENTS

exponent sign

limiting sign

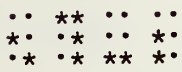
1. x p

2. x p + q (= x^{p+q})



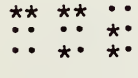
3. 2 3 (= 2^3)

4. 5 - 2 (= 5^{-2})



5. a 4 (= a^4)

6. c m 2 (= cm^2)



Notes:

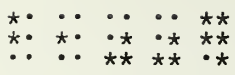
1. When the exponent is a positive number following an alphabetic symbol, the exponent sign is omitted.

2. Multipliers are written before letters by convention.

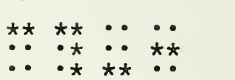
3. Only one numeral or letter may be used as an exponent unless terminated by the termination sign (L) or enclosed in brackets.

4. The termination sign (L) may only have one meaning in a given expression.

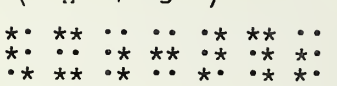
7. b 1 0 0 L (= b^{100})



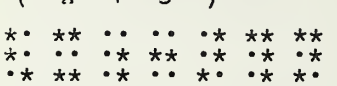
8. c - 3 (= c^{-3})



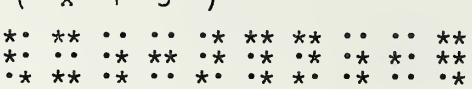
9. (x + 3) 2 (= $(x+3)^2$)



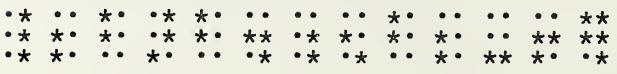
10. (x + 3) n (= $(x+3)^n$)



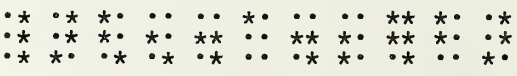
11. (x + 3) n + 1 L (= $(x+3)^{n+1}$)



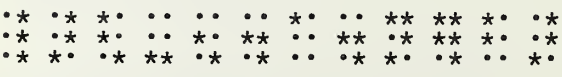
12. 2b√ b 4 + 5 b 2 - 6 L (= $\sqrt[2b]{b^4+5b^2-6}$)



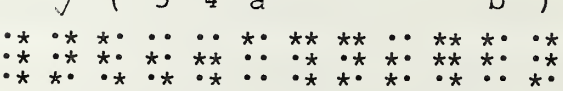
13. √ (5 4 a 4 2 L b) (= $\sqrt{54a^{42}b}$)



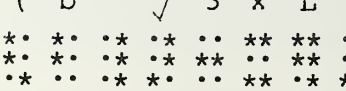
14. √ (- 5 4 a 4 n L b) (= $\sqrt{-54a^{4n}b}$)



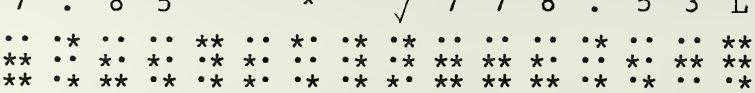
15. √ (5 4 a n 2 b) (= $\sqrt{54a^{n^2}b}$)



16. (b √ 3 x L) 3 (= $(b\sqrt{3x})^3$)

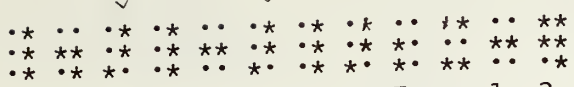


17. 7 . 8 5 2 * √ 7 7 8 . 5 3 L (= $7.85^2 . \sqrt{778.53}$)



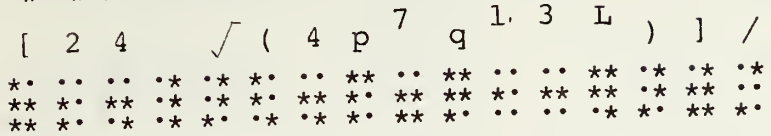
Note the "*" sign in the above example separates the two parts of the expression because it is an operational sign.

18. $\sqrt[4]{\sqrt[3]{\sqrt{2x^3}}}$ L

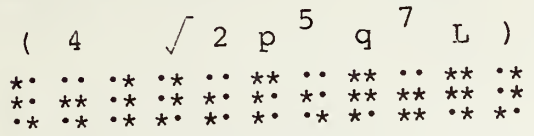


(= $\sqrt[4]{\sqrt[3]{\sqrt{2x^3}}}$)

19. [2 4 $\sqrt{}$ (4 p^7 q^{13} L)] /



(4 $\sqrt{}$ 2 p^5 q^7 L)



(= (24 $\sqrt{4p^7q^{13}}$) ÷ (4 $\sqrt{2p^5q^7}$))

suffix sign	⠀⠆ ⠀⠒	
prime	⠀⠆ ⠀⠆ ⠀⠒ ⠀⠒	(e.g. x')
double prime	⠀⠆ ⠀⠆ ⠀⠆ ⠀⠒ ⠀⠒ ⠀⠒	(e.g. x")
superscript sign	⠈⠆ ⠈⠒	

Examples:-

1. x ' (= x')

⠭ ⠄⠆ ⠄⠆
⠄⠆ ⠄⠆ ⠄⠆
⠭ ⠄⠒ ⠭

2. x ' 2 (= x'^{2})

⠭ ⠄⠆ ⠄⠆ ⠭ ⠄⠆
⠄⠆ ⠄⠆ ⠄⠆ ⠄⠒ ⠈⠒
⠭ ⠄⠒ ⠭ ⠄⠒ ⠈⠒

3. x (= x_2)
2

⠭ ⠄⠆ ⠄⠆
⠄⠆ ⠄⠆ ⠈⠒
⠭ ⠄⠒ ⠈⠒

4. x ' 2 (= x'^{2}_{1})
1

⠭ ⠄⠆ ⠄⠆ ⠄⠆ ⠭ ⠄⠆
⠄⠆ ⠄⠆ ⠄⠆ ⠈⠒ ⠄⠒ ⠈⠒
⠭ ⠄⠒ ⠭ ⠄⠆ ⠄⠒ ⠈⠒

Notes:-

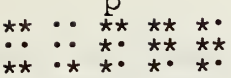
1. The suffix indicator is omitted after the prime.

2. There shall be only one braille cell used after a suffix or superscript sign, unless the sign is followed by a limiting sign (L) or an exponent sign.

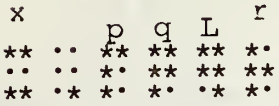
5. x ' ' L - y ' ' L (= x" - y")

⠭ ⠄⠆ ⠄⠆ ⠄⠆ ⠭ ⠄⠆ ⠄⠆ ⠄⠆ ⠄⠆ ⠭
⠄⠆ ⠄⠆ ⠄⠆ ⠄⠆ ⠭ ⠄⠆ ⠄⠒ ⠄⠆ ⠄⠆ ⠄⠆ ⠭
⠭ ⠄⠒ ⠭ ⠭ ⠄⠒ ⠭ ⠭ ⠄⠒ ⠭ ⠭ ⠄⠒

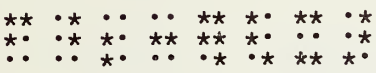
6. x p q r (= $x_{p}qr$)

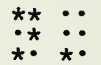


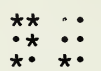
7. x p q L r (= $x_{pq}r$)



8. f 2 3 L (x) (= $f^{23}(x)$)

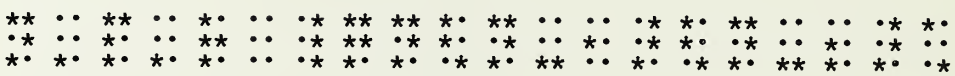


n, p, r  The number of permutations (p) of n items taken r at a time.

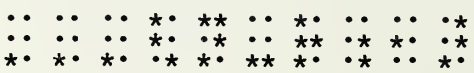
n, c, r  The number of combinations (c) of n items taken r at a time.

Examples:-

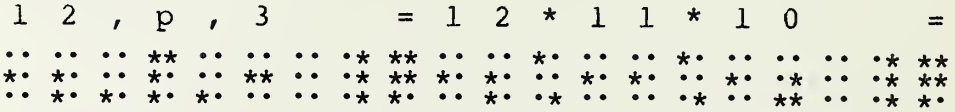
1. n , p , r = n (n - 1) (n - 2) *



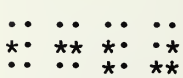
. . . (n - r + 1)



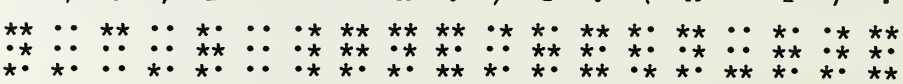
2. 1 2 , p , 3 = 1 2 * 1 1 * 1 0 =



1 3 2 0



3. n , c , r = n ! / r ! (n - r) !



SIGNS USED IN SET THEORY

$\{a,b,c\}$ — the set of a,b,c

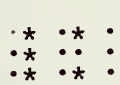
$\in$ — is a member (element) of

$\notin$ — is not a member (element) of

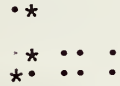
$\cup$ — union

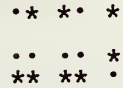
$\cap$ — intersection or product

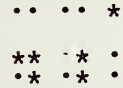
$\subset$ — subset

$\supset$  — contains

$|$ — such that

$\emptyset$  — null set or empty set

$\rightarrow$  — implies or tends to

$\not\subset$  — is not a subset of

Q — rational numbers

I — $\{\ldots,-3,-2,-1,\ 0,\ 1,\ 2,\ 3,\ldots\}$

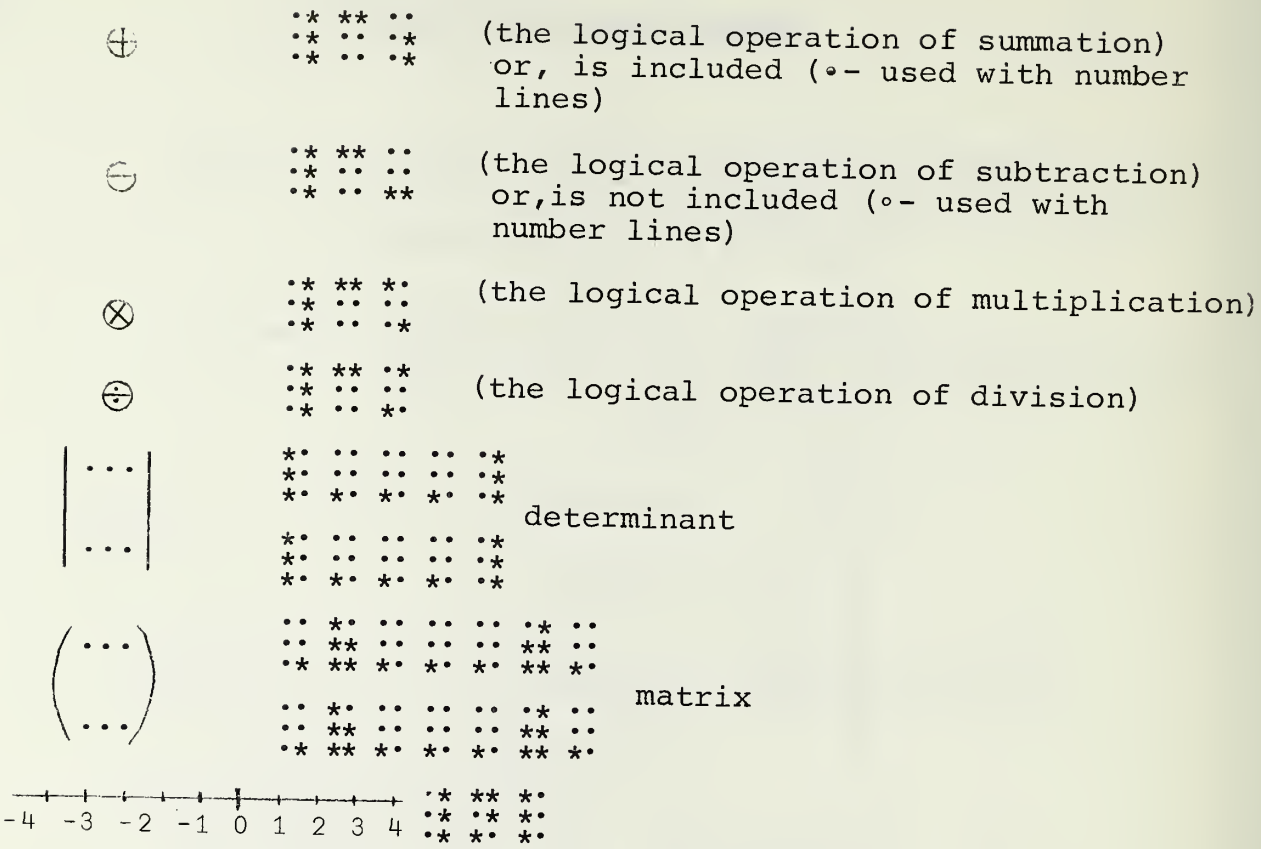
N —$\{1,2,3,4\ldots.\}$— counting numbers

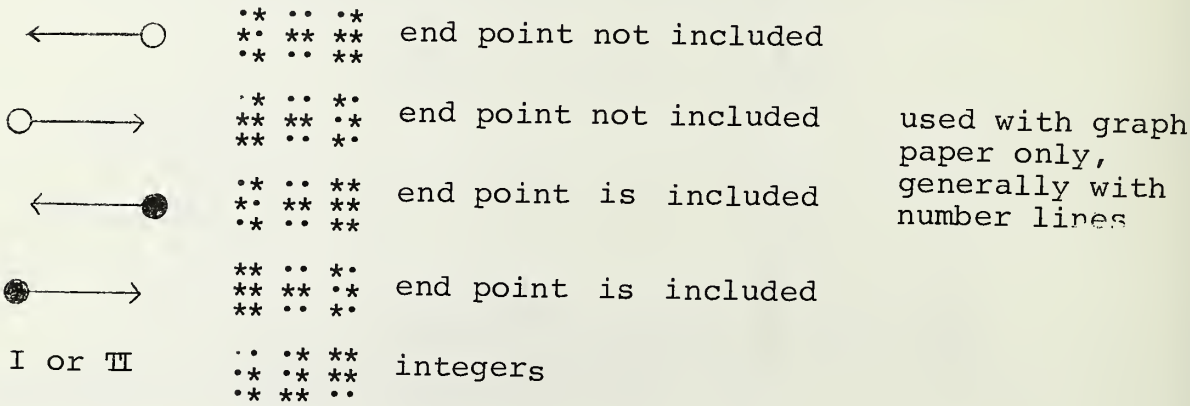
W —$\{0,1,2,3\ldots\}$

C — class of complex numbers (imaginary)

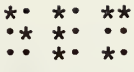
R — real numbers

$\circ$ — indicates the composite of functions,i.e.,$g \circ f$

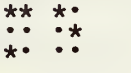

(the logical operation of summation)
or, is included (∘- used with number lines)
(the logical operation of subtraction)
or,is not included (∘- used with number lines)
(the logical operation of multiplication)
(the logical operation of division)
determinant
matrix
-4 -3 -2 -1 0 1 2 3 4


end point not included
end point not included
used with graph paper only, generally with number lines
end point is included
end point is included
I or II
integers

is an element of set

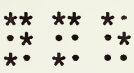


is a member of set



is not an element of set

is not a member of set



union or sum

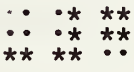
intersection or product

subset

contains

null set or empty set

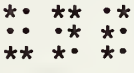
negative integer



(Note: this is not often used)

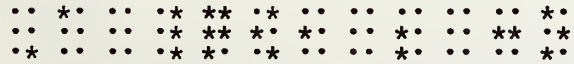
solution set

universal set



Note: In the examples below the actual meaning of the braille is shown without brackets

1. A = { 1 2 3 }

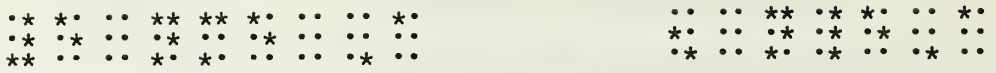


(A is the set of the members 1, 2, 3)

2. (1 ∈ A) or 1 ∈ A

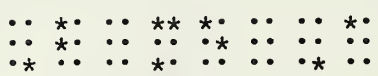
1 is a member of set A

3. (5 ∉ A) or 5 ∉ A



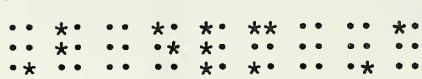
5 is not a member of set A

4. (B ∈ A)



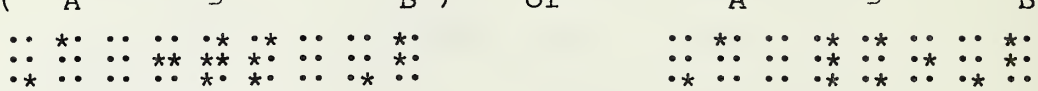
B is a member of set A

5. (B ∈ A)



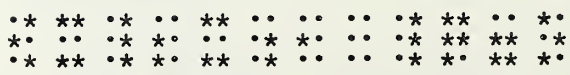
B is an element of set A

6. (A ⊃ B) or A ⊃ B



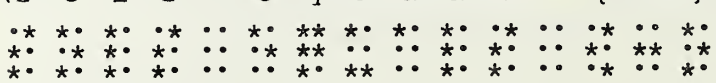
A contains B

7. { x | 2 x + 1 = 7 }



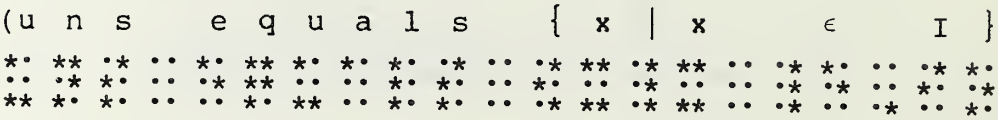
(the set of x such that 2x + 1 = 7)

8. (s o l s e q u a l s { 3 })



solution set equals the set of 3

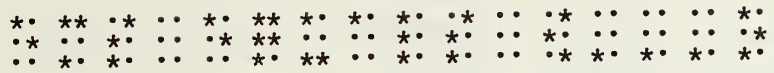
9. (u n s e q u a l s { x | x ∈ I })



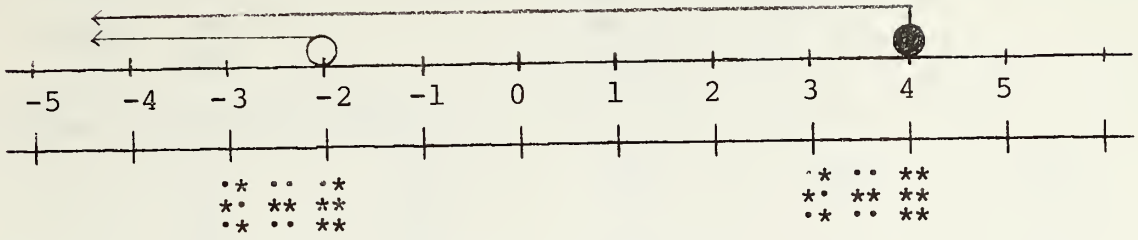
universal set equals x such that x is a member of the class of integers

i.e. the universal set is the set of all integers

10. The empty set equals { . . . }

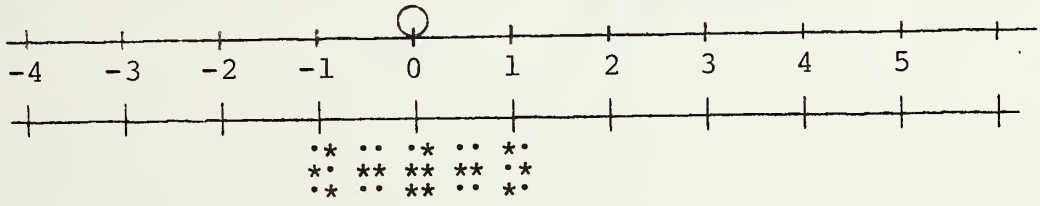


11.

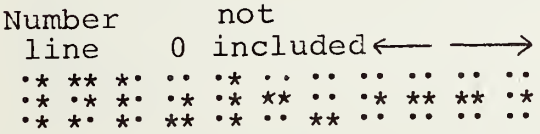


or Number line - 2 not included ←, 4 is included ←

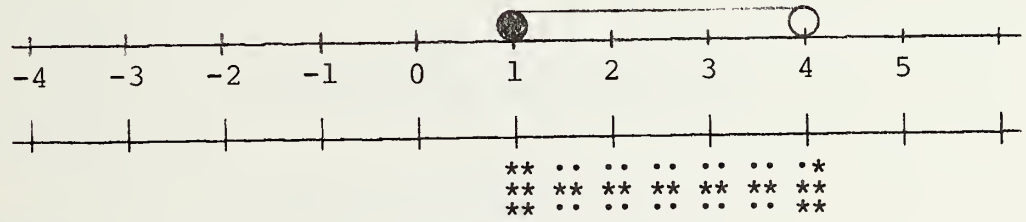
12.



or Number line 0 not included ← →



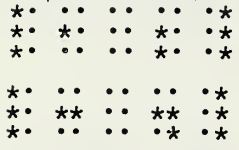
13.



or Number line 1 is included → 4 not included

14. $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ matrix

15. $\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$ determinant



$\log_{10}$ or log

$\log_e$ or ln (natural or Naperian logarithms)

base

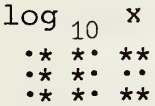
Negative characteristics:-

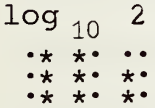
$\bar{1}$ or $\bar{1}$ $\bar{2}$ $\bar{3}$ $\bar{4}$ $\bar{5}$

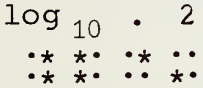
$\bar{6}$ $\bar{7}$ $\bar{8}$ $\bar{9}$ $\bar{0}$

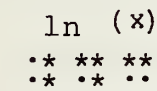
These symbols, used in logarithms, are made up with the numbers in the upper register together with the minus symbol below.

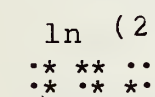
Examples:-

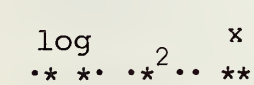
1. $\log_{10} x$ 

2. $\log_{10} 2$ 

3. $\log_{10} .2$ 

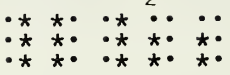
4. ln (x) (sometimes written $\log_e x$) 

5. ln (2) (sometimes written $\log_e 2$) 

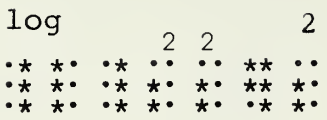
6. log ^{2} x (= $\log_2 x$) 

(Note: After using the base indicator sign together with a log sign, only one numeral or alphabetic symbol may be used unless the limit sign is used to denote the end of the base.)

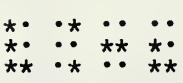
7. $\log_2 2$ (= $\log_2 2$)



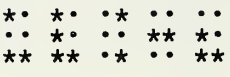
8. $\log_{2^2} 2$ (= $\log_{2^2} 2$)



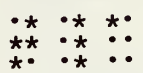
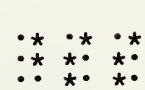
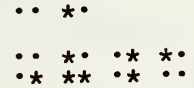
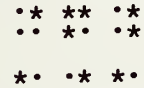
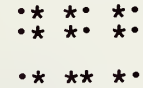
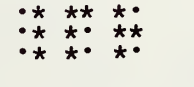
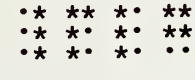
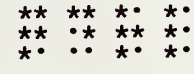
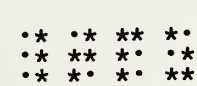
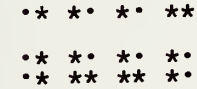
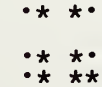
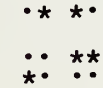
9. $\bar{2}.38$



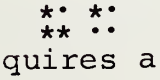
10. $\overline{12}.38$



Symbols and abbreviations:

+	plus	
-	minus	
∠	angle	
△	triangle	
□	square	
	base	
	bisect	
	side	
	sides	
	right angle	
	rectangle	
//	parallel	
⊥	perpendicular to	
▱	parallelogram	
	quadrilateral	
	trapezium	
	rhomboid	
	rhombus	
∵	because	
∴	therefore	

Note: The sign below requires a space left before it.

~	is similar to	

$\cong$ or $\tilde{=}$ is congruent to

Note: This sign requires a braille space left before it.

is perpendicular to and equal to

is parallel to and equal to

area of triangle

area of square

area of parallelogram

area of rectangle

$\odot$ circle (symbol)

circle (in writing)

centre

circumference

chord

diameter

radius

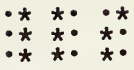
radi

point

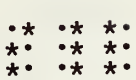
ray

segment

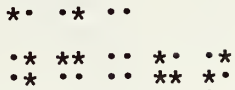
line

lines 

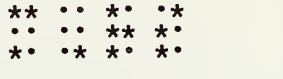
theorem

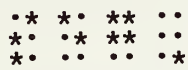
straight line 

measure of angle

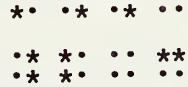
arc endpoints RS 

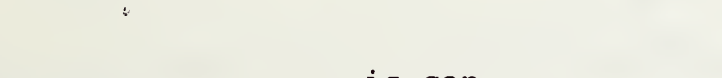
measure of arc RS

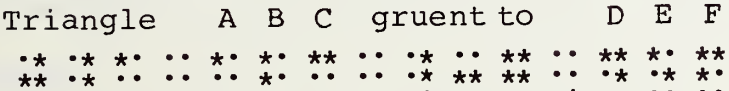
segment AB 

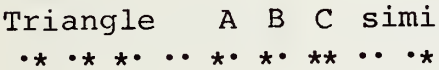
length AB 

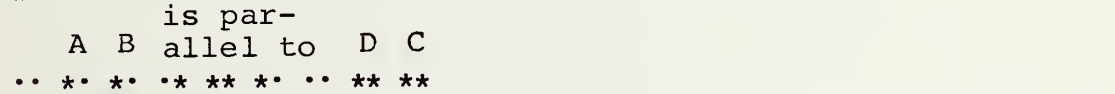
line through points X and Y

ray endpoint R 

1. Triangle A B C is congruent to D E F 

2. Triangle A B C is similar to D E F 

3. A B is parallel to D C 

4. In parallelogram A B C D A B is parallel and equal to D C 

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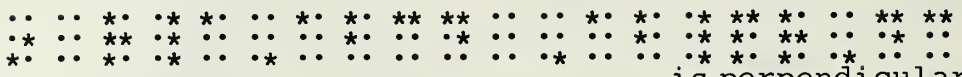
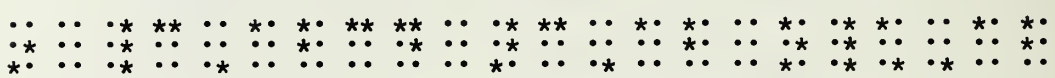
NEW YORK, NY 10011

5. In rectangle A B C D A B is perpendicular to D C

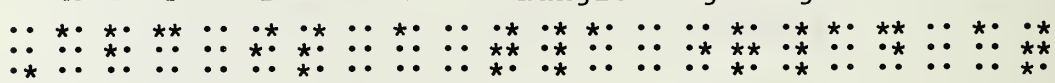


6. In square A B C D A B is perpendicular and equal to B C

7. In circle A B C D arc A B > chord A B

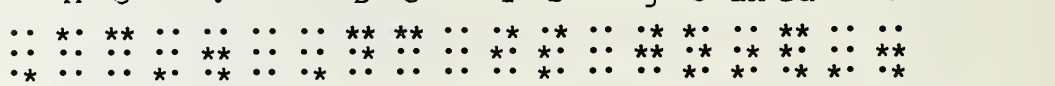


8. A B C is a triangle rightangled at

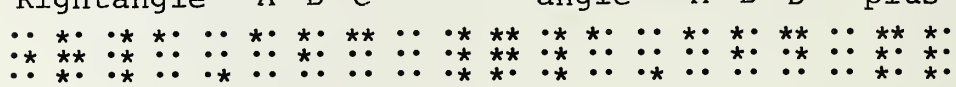


B . D is any point in

A C . D C is joined .



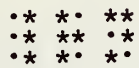
Rightangle A B C = angle A B D plus



angle D B C .

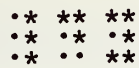
In addition to the signs for °, ', and ", the following are also used:-

radian



△x - delta x

△y - delta y

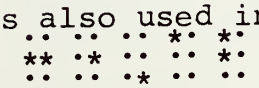


→

←

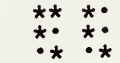
(Note: The → sign is also used in vectors, i.e.,

$\vec{AB}$ (vector AB)



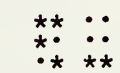
sine

cosecant



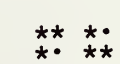
cosine

secant



tangent

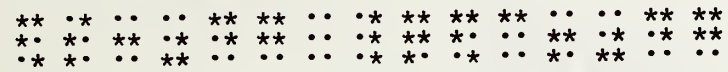
cotangent



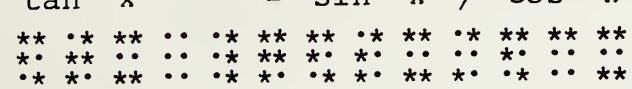
(Note the pairs sine-cosecant, cosine-secant, tangent-cotangent)

Examples:-

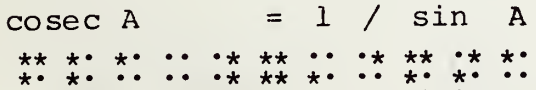
1. sin 30° = cos 60°



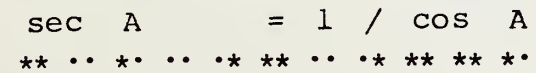
2. tan x = sin x / cos x



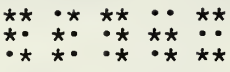
3. cosec A = 1 / sin A



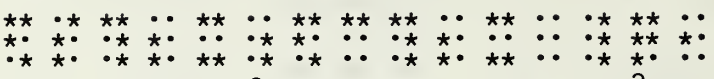
4. sec A = 1 / cos A



5. $\sin^{4} x$

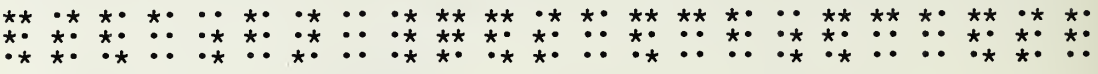


6. $\sin^{2} x + \cos^{2} x = 1$

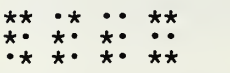


7. $1 + \cot^{2} x = \operatorname{cosec}^{2} x$

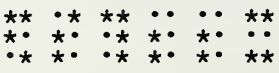
8. $\sin(A + B) = \sin A \cos B + \cos A \sin B$



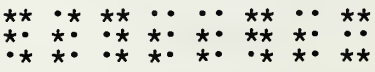
9. $\sin 2x$



10. $\sin^{2} 2x$

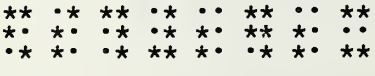


11. $\sin^{2}{}^{2} 2x$

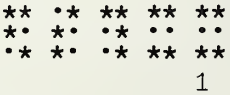


(Note: After using the exponent sign together with a trigonometry sign only one numeral or alphabetic symbol may be used unless the limit sign ** is used to denote the end of the exponent.)

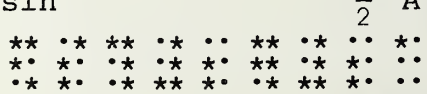
12. $\sin^{\frac{1}{2}} 2x$ $\left(= \sin^{\frac{1}{2}} 2x \right)$



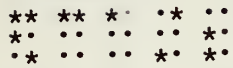
13. $\sin^{x} x$ $\left(= \sin^{x} x \right)$



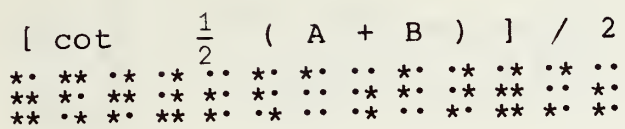
14. $\sin^{\frac{1}{2}} \frac{1}{2} A$ $\left(= \sin^{\frac{1}{2}} \frac{1}{2} A \right)$



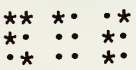
15. cos A / 2 $\left(= \frac{\cos A}{2}\right)$



16. [cot $\frac{1}{2}$ (A + B)] / 2 $\left(= \frac{\cot\frac{1}{2}(A+B)}{2} \right)$



INVERSE CIRCULAR FUNCTIONS

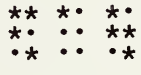
$\sin^{-1}$ or arc sine 

$\cos^{-1}$

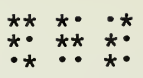
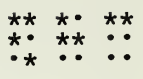
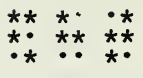
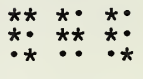
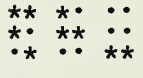
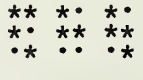
$\tan^{-1}$

cosec^{-1}

$\sec^{-1}$

$\cot^{-1}$ 

HYPERBOLIC FUNCTIONS

sinh	(pronounced shine)	
cosh	(pronounced cosh)	
tanh	(pronounced than	
cosech	(pronounced coshec)	
sech	(pronounced shec)	
coth	(pronounced coth)	

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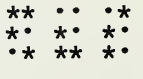
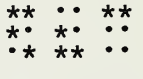
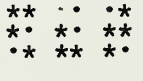
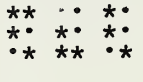
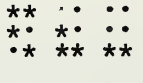
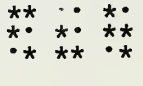
$\sinh^{-1}$	
$\cosh^{-1}$	
$\tanh^{-1}$	
cosech^{-1}	
sech^{-1}	
$\coth^{-1}$	

OTHER SIGNS

(limits) ⠠⠂ ⠐⠂ ⠐⠂ ⠐⠂ ⠠⠠ ⠠⠂ ⠐⠂ ⠐⠂ ⠐⠂ ⠠⠠ ⠠⠄ ⠄⠄ ⠄⠄ ⠄⠄ ⠄⠠ (used after signs such as $\leqslant$, $\int$)

$\sum_{n=1}^{q}$ ⠠⠂ ⠠⠂ ⠠⠄ ⠠⠠ ⠐⠂ ⠠⠂ ⠠⠠ ⠐⠂ ⠐⠂ ⠠⠠ ⠠⠠ sum limit n = 1 , q
⠠⠂ ⠠⠄ ⠠⠄ ⠠⠂ ⠐⠂ ⠠⠂ ⠠⠠ ⠠⠄ ⠐⠂ ⠠⠠ ⠠⠠
⠠⠂ ⠠⠄ ⠠⠄ ⠠⠄ ⠐⠂ ⠠⠂ ⠠⠄ ⠐⠂ ⠠⠄ ⠠⠄ ⠠⠂

$\frac{\delta y}{\delta x}$ ⠠⠂ ⠠⠠ ⠠⠠ ⠠⠂ ⠠⠂ ⠠⠠ ⠠⠠
⠐⠂ ⠠⠂ ⠠⠂ ⠐⠂ ⠐⠂ ⠠⠂ ⠐⠂
⠠⠂ ⠐⠂ ⠠⠠ ⠠⠄ ⠠⠂ ⠐⠂ ⠠⠠

$\frac{dy}{dx}$ ⠠⠠ ⠠⠠ ⠠⠂ ⠠⠠ ⠠⠠
⠠⠂ ⠠⠂ ⠐⠂ ⠠⠂ ⠐⠂
⠐⠂ ⠠⠠ ⠠⠄ ⠐⠂ ⠠⠠

$\frac{d}{dx}\left(\frac{u}{v}\right)$ ⠠⠠ ⠠⠂ ⠠⠠ ⠠⠠ ⠠⠄ ⠠⠄ ⠠⠂ ⠠⠄ ⠠⠂
⠠⠂ ⠐⠂ ⠠⠂ ⠐⠂ ⠠⠄ ⠐⠂ ⠐⠂ ⠠⠄ ⠠⠂
⠐⠂ ⠠⠄ ⠐⠂ ⠠⠠ ⠠⠂ ⠠⠠ ⠠⠄ ⠠⠠ ⠠⠄

$\frac{d^2y}{dx^2}$ ⠠⠠ ⠐⠂ ⠠⠠ ⠠⠂ ⠠⠠ ⠠⠠ ⠐⠂
⠠⠂ ⠠⠄ ⠠⠂ ⠐⠂ ⠠⠂ ⠐⠂ ⠠⠄
⠐⠂ ⠠⠄ ⠠⠠ ⠠⠄ ⠐⠂ ⠠⠠ ⠠⠄

$\frac{d^ny}{dx^n}$ ⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠ ⠠⠂ ⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠
⠠⠂ ⠠⠂ ⠠⠂ ⠠⠂ ⠐⠂ ⠠⠂ ⠐⠂ ⠠⠂ ⠠⠂
⠐⠂ ⠠⠂ ⠠⠄ ⠠⠠ ⠠⠄ ⠐⠂ ⠠⠠ ⠠⠂ ⠠⠄

$\int$ ⠠⠂
⠠⠄
⠠⠠

$\int_a^b$ ⠠⠂ ⠠⠄ ⠠⠄ ⠐⠂ ⠠⠄ ⠠⠠
⠠⠄ ⠠⠄ ⠐⠂ ⠐⠂ ⠠⠄ ⠠⠠
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$\frac{\partial y}{\partial x}$ ⠠⠂ ⠠⠂ ⠠⠠ ⠠⠠ ⠠⠂ ⠠⠂ ⠠⠂ ⠠⠠ ⠠⠠
⠐⠂ ⠠⠂ ⠠⠂ ⠠⠂ ⠐⠂ ⠐⠂ ⠠⠂ ⠠⠂ ⠐⠂
⠠⠂ ⠐⠂ ⠐⠂ ⠠⠠ ⠠⠄ ⠠⠂ ⠐⠂ ⠐⠂ ⠠⠠

Note: Brackets are shown around letters not usually used in mathematics.

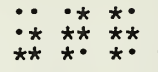
			Capital	Small
alpha	(A)	α		
beta	B	β		
gamma	Γ	γ		
delta	Δ	δ		
epsilon	(E)	ϵ		
zeta	(Z)	ζ		
eta	(H)	η		
theta	Θ	θ		
iota	(I)	ι		
kappa	(K)	k		
lambda	Λ	λ		
mu	(M)	μ		
nu	(N)	ν		
xi	Ξ	ξ		
(omicron	O	o)		
pi	Π	π		
rho	(P)	ρ		

GREEK ALPHABET

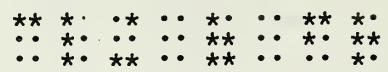
			Capital	Small
sigma	Σ	σ or s		
tau	T	τ		
upsilon	Y	(~)		
phi	O	φ		
chi	(X)	x		
psi	Ψ	ψ		
omega	Ω	ω		

Other contractions used by Dr. S. R. Hussey in his original version of the Halifax Code were:-

by transposing



clearing of fractions



complete

divide

equation

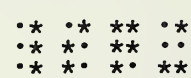
method

page #

quadratic

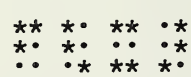
sign

squaring

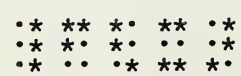


———————

f(x)



$\phi(x)$



APPENDIX II

MODIFICATIONS FOR ELEMENTARY STUDENTS

Students just starting school sometimes require there to be an intermediate step before adopting the full code. There are two basic changes which are used up to and including Grade 3:-

(1) All whole numbers are preceeded by a number sign and are written in the upper register.

(2) Fractions are written as described for the code except that for fractions of the type $\frac{1}{3}$ the 1 is always included.

ONE-LINE METHOD OF CALCULATION

AS USED BY DR. S. R. HUSSEY

The method of teaching arithmetic, as briefly outlined below, will at first appear to be confusing and complicated, but if taught from the beginning, it is effective. Perhaps the greatest tribute to the system when adhered to was that rarely in our school did a student dislike mathematics because of a better understanding, he was able to cope with it.

Although the system was developed primarily for the so-called normal child who was capable of completing high school, it can be used with exceptional children to the limit of their capacity to engage in a mathematical program. The method used in teaching elementary addition and subtraction eliminates the necessity of carrying and borrowing which concepts are difficult for the slow learning child to grasp. It is also very effective in teaching money problems.

A braille writer is the nearest substitute that a braille student has for a pencil to record mathematical calculations, and the on-line method is the most practical, simple, and realistic means of doing it.

To make this method more effective, some adjustments have to be made in teaching the braille student addition, subtraction and multiplication to avoid back-spacing wherever possible. The visual concept of the format taught to the sighted is of little or no value to the totally blind child.

The major change in teaching methods in dealing with the three operations mentioned above is that calculation is done from the left side instead of the right, e.g., to add two 3-digit numbers such as 234=567, the second of the two numbers is left intact and the hundreds of the first is added to it, then the tens are added, then the units. The child, after the first step, says 767; after the second, 797; after the final step, 801.

At first it may be necessary for the student to record the answer after each operation, but with practice the average child completes the addition in one trend of thought and arrives at the answer in amazingly short time. If one has to add four or more such numbers, the process is the same - the first is added to the second, that answer added to the third, etc. Again, at first the answer of each addition may have to be recorded. This method avoids back-spacing, recording the answer in the reverse order to how it is read, as the sighted child has to do.

SUBTRACTION

Here,again,the calculation is done from the left. In subtracting 57 from 89, 50 is taken from 80 = 30; 7 from 9 = 2; answer is 32. If the units digit of the subtrahend is greater than that of the minuend, it is subtracted from the even tens immediately above it; e.g., 74 - 48, the student would say to himself 48 from 50 = 2, 50 from 74 = 24 + 2 = 26. This method avoids borrowing and can be done very quickly.

In preparation for subtracting a third digit number, the first step to be emphasized is the subtraction of any number of two digits from 100, as for example: 43 from 100, 67 from 100, and so on. The method used is to subtract the number from the even tens immediately above it. In the case of 43 from 100, the 43 is taken from 50, leaving 7, and from 50 to 100 is 50. The remainder is then 7 and 50 or 57. 67 from 100 equals 3 plus 30, equals 33. If the child's foundation is good, such subtraction is done almost instantaneously.

The next step is to subtract any three-digit multiple of ten from the hundreds immediately above it, such as 320 from 400, 460 from 500, and 670 from 700. A unit digit is then added to the subtrahend - 326 from 400, 467 from 500. One must remember to subtract from the even tens immediately above the subtrahend first of all, thus: 326 from 330 equals 4, 330 from 400 equals 70. Answer: 70 plus 4 equals 74.

We are now in a position to expand our minuend, first to any even hundred. Using our 326, let us

subtract it from 600, 800, 900. Then let us add any number of tens to the minuend, (for example: 326 from 520), and finally let us add the unit digits such as 326 from 517. By the time this last stage is reached, the pupil should be able to take the 326 from 400 with no effort and add this remainder of 74 to 117, which is the difference between 400 and 517 to it, thus getting the answer of 191. This method of subtraction might be called the money-changing method. The only time one would deviate from it would be in subtracting our 326 from a number such as 445, where the 45 is larger than the 26. Here, the 26 is taken from 30, and the remainder, 4, added to 15, which is the difference between 30 and 45. The 19 thus obtained is added to the difference between the hundreds and gives the final answer of 119.

MULTIPLICATION

It is assumed that the child knows his tables, preferably to 12 x 12.

Step 1. Multiply each of the following numbers by 6: 20, 40, 60, 90, 70, 50. The student would first think, "There are two tens in 20; 6 by two tens = 12 tens = 120". With a little practice, the student answers promptly 20 x 6 - 120; 40 x 6 = 240; 60 x 6 = 360; and so on.

Step 2. Multiply each of the following numbers by 7: 800, 600, 700, 900. Here again, we should aim at prompt replies, 800 x 7 = 5,600, etc.

Step 3. To multiply 87 by 9 the student goes through the steps: 87 x 9 = 720, + 63 = 783. He finally, with practice, reduces this to the one process 87 x 9 = 783.

Step 4. To multiply 573 by 8, the stages are: 573 x 8 = 4,000 + 560 = 4,560, + 24 = 4,584. Again, with no more than a reasonable amount of drill, the student can apparently make the calculation in one "jump".

Step 5(a). Multiply 87 by 27: 87 x 9 x 3 (factoring the 27) = 783, x 3 + 21,100 + 240 + 9 = 2,349.

(b). Where neither number is factorable:
43 x 23 - (43 x 20) + (43 x 3) = 860 + 129 = 989.

(c). 87 x 39 = 87 x 40 - 87 = 3,480 - 87
= 3,393.

Note that in (c) 39 is 1 less than 40; therefore, we multiply by 40 and subtract 87.

Multiplying by a three digit number, the one-line method is used. It, of course, can be used with two digit numbers if desired.

DIVISION

The first steps in division are taken in the usual manner, that is, the division of one-, two-, and three-digit numbers by 2, 3, 4, etc. The work is done orally until the teacher is satisfied that the child has mastered the mechanics of this and keeps his place values straight. Thus: 78 divided by 2, 2 in 7, 3 and 1 over, answer 30, 2 into 18, 9, answer 39. Similarly with a three-digit number 554 divided by 2, the first 2 in the answer is 200, the 7 is tens and the last 7 units. Since the child is working mentally, the oral recitation and mental concept of results is important, for they are the substitute for what the normal child does with the pencil. Practice and confidence result in surprising skill and speed in dividing five or six-digit numbers by any number up to 12.

In dividing by any two digit number that can be factored, we can divide by the factor or by the number directly. Where the number itself is used it is set down thus: $\underline{28(9,688)}$. It is recorded this way to avoid
346
awkward spacing for the student on the braille writer. The method used in doing the question is the same as in ordinary short division.

In the following question note that the answer is placed in a perpendicular line to the right. This is done to save awkward spacing or roll-back.

To divide 7751265 by 365

365)775265	answer
730	
452	2
365	
876	1
730	
1465	2
1460	
5	4

Answer 2,124 R 5

If 55,854 were to be divided by 36, the 36 would be factored into 12 and 3. The quotient when divided by 12 is 4654 and a remainder of 6. Then 4654 divided by 3 equals 1,551 and a remainder of one. Since this second remainder is a multiple of 12, the total remainder is 1 x 12 plus 6 or 18/36 equals 1/2.

In dividing by a three-digit number such as 241, it is recommended after the operations have been mastered that only the remainder be shown each time, and the quotient be shown as indicated above.

241)773,548	3
505	2
2348	0
179	9

179

Quotient 3,209

In addition to the complete one-line method of multiplication, there is also, in fact, a one-line method of division. Dividing by 99 is perhaps the simplest example of this method. Since 99 is one less that 100, we use 100 as a trial divisor. We note that 100 will go into 773 seven times with a remainder of 73. 99 will also go 7 times with a remainder of 73 plus 7, since 7 multiplied by 99 is 7 less than 7 multiplied by 100. Care has to be exercised if we are dividing

895 by 99. It obviously goes 8 times with a remainder of 99 plus 8, which is sufficient to make it 9 times with a remainder of 4.

Try dividing 773,548 by 99. Regard the 99 as 100 minus 1. Check your answer by one-line multiplication.

100 as a trial divisor is used for numbers between 95 and 105. Dividing by 103 for instance, is regarded as 100 plus 3. Any even hundreds or tens is used in similar manner for dividing by numbers, whether for units above or below such number. For example, 69 is regarded as 70 minus 1, 52 is 50 plus 2, 123 as 120 plus 3.

For a child to be proficient in coping with this system of calculation it is essential that he get a solid background in the elementary grades. From the time he learns to count to ten, both forward and backward (for both operations of addition and subtraction are taught simultaneously) he is learning number concepts. A digit only assumes meaning when it is seen in its place in relationship to the others. Then the primary addition and subtraction facts become easy. Once the secondary facts are mastered, all are expanded to multipliers of 10. Thus, if 4 + 3 = 7, so also do 4 tens and 3 tens = 7 tens, or 70. The same is true of hundreds and thousands. The teacher must be sure that the child understands what he is doing. This can be easily checked.

The number and variety of exercises that can be used in teaching arithmetic in this manner, for reinforcement or drill, are limited only by the ingenuity of the teacher as she sees the areas where further practice is required.

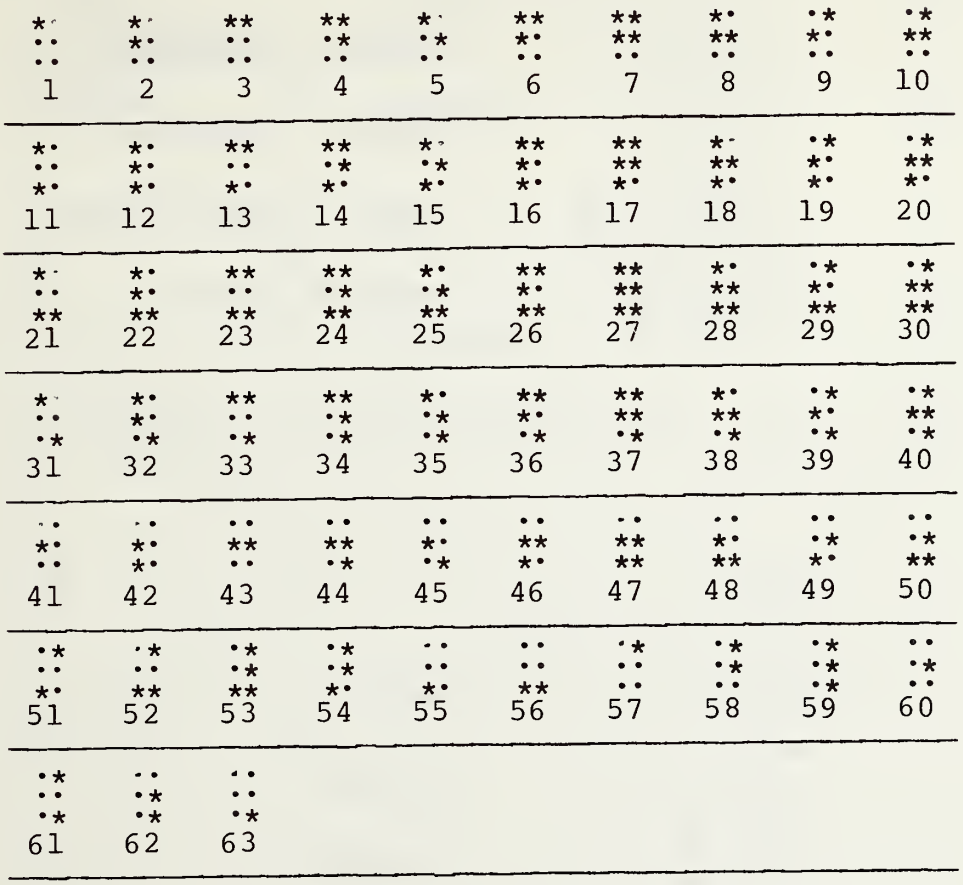
This method of teaching is more demanding of a student than the traditional system used with the sighted child. This is so because most the the calculations are done mentally to reduce the amount of recording that would have to be done on a braille writer and to teach

the student to use his mental capacity. He has to think more and concentrate harder on what he is doing, but it does pay off. Each year of training in mental calculation better prepares him for future mathematical training, and his post-schooling life, for day-to-day math problems can be solved mentally; thus freeing him from any tool or crutch, none of which may be at hand when required.

INDEX I

BRAILLE SYMBOLS

The following is the list of the 63 braille symbols arranged in their standard order and numbered in accordance with its rank in the list.



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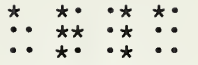
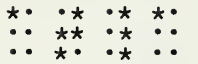
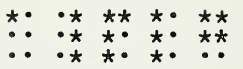
			area of rectangle	30
			area of triangle	30
			area of parallelogram	30
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	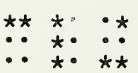		clearing	40
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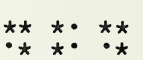
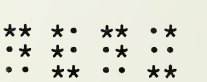
			divide	40
			dividing	40

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			empty (or null) set	23
			equation	40
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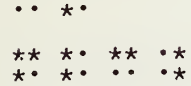
			fraction	40
		f(x)	function of (x)	40
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8.		h		
9.		i		
10.		j		
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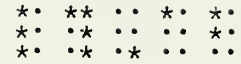
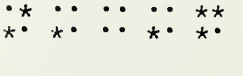
12.		l	
		opening of "absolute value of"	7
		opening of determinant	7
		length AB	31
13.		m	
		' (minutes)	9
		member of set, is a	23
		method	40
		minus	29
		measure of angle	31
		measure of arc RS	31
14.		n	
		not a member of set, is	23
		≯ (not greater than, is)	5
		≮ (not less than, is)	5
		combinations (n,c,r)	20

Page

14. ⠭ continued

⠭⠭ ⠒⠒ ⠎⠒ ⠎⠒ ⠭⠭ ⠒⠭ ⠒⠒ ⠒⠭ ⠎⠒ ⠒⠒ ⠎⠒ ⠎⠒ ⠒⠒ ⠎⠒ ⠎⠒ not an element of set, is 23

⠭⠭ ⠒⠒ ⠭⠭ ⠒⠒ ⠎⠒ ⠒⠭ ⠒⠒ ⠎⠒ ⠒⠒ ⠭⠭ ⠎⠒ ⠎⠒ ⠎⠒ ⠎⠒ ⠎⠒ permutations (n,p,r) 20

⠭⠭ ⠒⠭ ⠎⠒ ⠒⠭ ⠒⠭ ⠒⠭ ⠎⠒ ⠒⠭ ⠒⠒ ∉ (not an element of set, is) 21

⠭⠭ ⠒⠭ ⠭⠭ ⠒⠭ ⠒⠭ ⠭⠭ ⠎⠒ ⠒⠭ ⠎⠒ ≠ not equal to, is 5

⠭⠭ ⠒⠭ ⠒⠒ ⠒⠭ ⠒⠭ ⠒⠭ ⠒⠒ ⠎⠒ ⠒⠭ ⠒⠒ ⊄ (not a subset of, is) 21

15. ⠎⠒ ⠒⠭ ⠎⠒ o

⠎⠒ ⠒⠭ ⠎⠒ > (greater than, is) 5

⠎⠒ ⠒⠭ ⠎⠒ } (close of curly bracket) 7

⠎⠒ ⠒⠭ ⠎⠒ ⠭⠭ ⠒⠭ ⠭⠭ ⠎⠒ ⠒⠭ ⠎⠒ ≥ (greater than or equal to,is) 5

16. ⠭⠭ ⠎⠒ ⠎⠒ p

⠭⠭ ⠎⠒ ⠎⠒ ⠎⠒ ⠎⠒ plus 29

⠭⠭ ⠒⠭ ⠎⠒ ⠒⠭ ⠎⠒ ⠭⠭ page number 40

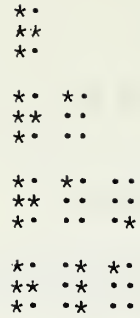
17. ⠭⠭ ⠭⠭ ⠎⠒ q

⠭⠭ ⠭⠭ ⠎⠒ ⠭⠭ ⠒⠭ ⠭⠭ ⠎⠒ ⠒⠒ ⠎⠒ quadratic 40

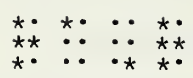
⠭⠭ ⠭⠭ ⠎⠒ ⠎⠒ ⠭⠭ ⠒⠭ ⠭⠭ ⠎⠒ ⠎⠒ ⠒⠒ ⠎⠒ ⠎⠒ quadrilateral 29

Page

18. r



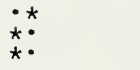
ray 30



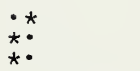
ray endpoint R 31

rectangle 29

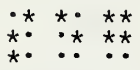
19. s



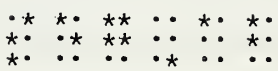
" (seconds) 9



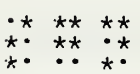
≤ (sum to infinity of, the) 11



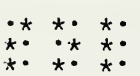
segment 30



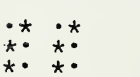
segment AB 31



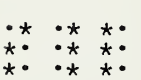
sign 40



solution set 23

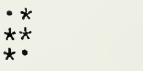


subset 23



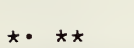
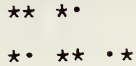
straight line 31

20. t



transposing 40

△ triangle 29

				Page
21.		u		
		1	(negative characteristic, -1)	27
			union, sum	23
			universal set	23
22.		v		
		2	(negative characteristic, -2)	27
23.		x		
		3	(negative characteristic, -3)	27
24.		y		
		4	(negative characteristic, -4)	27
25.		z		
		5	(negative characteristic, -5)	27
		as	(used in ratios)	5

			Page
26.			
		! (factorial)	11
		6 (negative characteristic, -6)	27
27.			
		∞ (infinity)	11
		7 (negative characteristic, -7)	27
28.			
		[(opening of square bracket)	7
		8 (negative characteristic, -8)	27
29.			
		9 (negative characteristic, -9)	27
		∴ Therefore	29
30.			
		] (close of square bracket)	7
		0 (negative characteristic, -0)	27

Page

30. continued

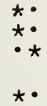
close of "additional brackets" 7

close of matrix 7,26

31.

x or .(multiplied by) 4

32.



((open round bracket) 7

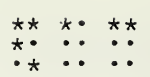
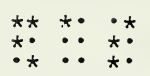
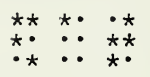
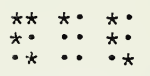
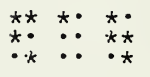
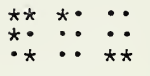
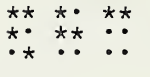
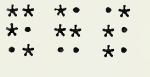
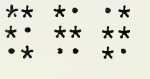
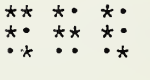
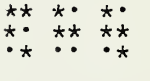
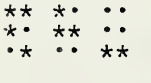
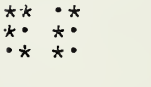
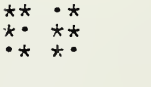
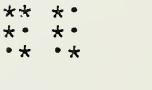
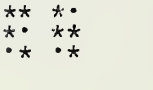
33.

: (ratio) 4

34.

(exponent sign) 15

35.

			Page
36.			
	$\cos^{-1}$	arc cosine	35
	$\sin^{-1}$	arc sine	35
	$\tan^{-1}$	arc tan	35
	cosec^{-1}	arc cosecant	35
	$\cot^{-1}$	arc cotangent	35
	$\sec^{-1}$	arc secant	35
	cos	cosine	33
	cosh		36
	sinh		36
	tanh		36
	cosech		36
	coth		36
	sech		36
	sin	sine	33
	tan	tangent	33
	cosec	cosecant	33
	cot	cotangent	33

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36. continued

$\cosh^{-1}$ arc cosh 36

$\sinh^{-1}$ arc sinh 36

$\tanh^{-1}$ arc tanh 36

cosech^{-1} arc cosech 36

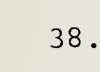
$\coth^{-1}$ arc coth 36

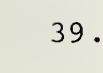
sech^{-1} arc sech 36

sec secant 33

37.

 (limiting sign) 7,13,15,18

38. 

39. 

 { (open curly bracket) 7

 < (is less than) 5

 ∅ (null set, empty set) 21

 ≤ (is less than or equal to) 5

Page

40. w

41.

42.

because 29

43.

% percent 9

contains 23

varies as 11

→ implies 21

— (line) 40

→ arrow (right) or (vector) 33

44. 4

45. 5

46. 6

Page

47.
7

48.
8

49.
9

50.
0

51.
/ or ÷ (over or divided by) 4

÷ (used with fractions) 4

52.

53.
(#) number sign 11

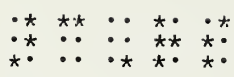
(fraction indicator) 3

Page

54.

) (close of round bracket) 7

(root sign) 13



arc endpoints RS 31

difference between, the 11

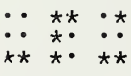
55.

, (mathematical comma) 11

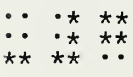
56.

- (minus) 4

complete 40



completing 40



negative integer 23

∓ (minus or plus) 4

57.

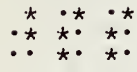
(vinculum) 7

Page

58.

(superscript sign) 18

side 29



sides 29

59.

(base indicator) 11,27

| (close of"absolute value of") 7

(root indicator) 13

_ (repeating decimal) 9

| (such that) 21

∠ (angle) 29

B Beta 38

base 29

O (circle) 30

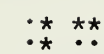
⊘ (multiplication(logical)) 22

⊖ (division(logical)) 22

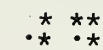
⊖ (subtraction(logical)) 22

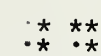
Page

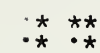
59. continued



 ⊕ (summation (logical)) 22

 Δ Delta 38

 diameter 30

 Δx (delta x) 33

Δy (delta y) 33

∈ (is a member (element) of) 21

Φ Phi 38

φ(x) phi of (x) 40

Γ Gamma 38

log, $\log_{10}$ 27

Λ Lambda 38

line 31

≈ or ~ or ≐ (is approximately equal to) 5

lines 31

line through points X and Y 31

l_n (natural logarithm) 27

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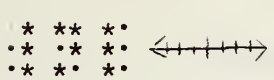
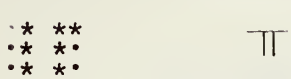
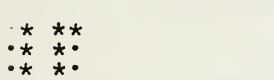
59. continued


number lines 22

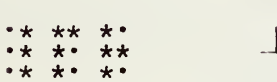

Pi 38


point 30

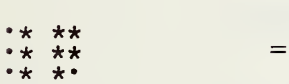
parallel 29

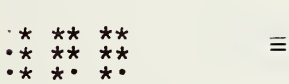
parallelogram 29

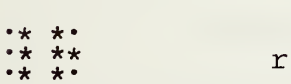
is parallel and equal to 30


is perpendicular to 29

is perpendicular and equal to 30

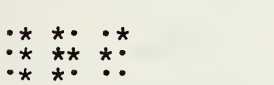

equals 5

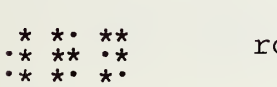

is identical to 5

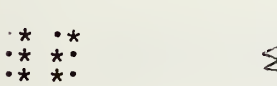

radius 30

rhomboid 29

rhombus 29


radi 30


radians 33


Sigma 39

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⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		squaring	40
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		trapezium	29
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	⌒	Upsilon	39
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		chord	30
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	∩	intersection, product	21
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⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		bisect	29
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		centre	30
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	≅	is congruent to	30
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		is not included	22
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		is included	22
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	⌠‾	(divided into)	4
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	∪	(union, sum)	21
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	√	(square root)	13
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒		circumference	30
⠒⠤⠒ ⠒⠤⠒ ⠒⠤⠒	⊂	(subset)	21

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60. ⠤

rightangle 29

← (arrow - left) 33

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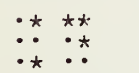
⠨ . (decimal point) 9

α (alpha) 38

β (beta) 38



δ (delta) 38

ε (epsilon) 38

φ (phi) 39

γ (gamma) 38

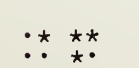
(iota) 38

κ (kappa) 38

λ (lambda) 38

μ (mu) 38

ν (nu) 38



π (pi) 38

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⠤⠒⠒⠒⠤⠤⠒⠤⠒	p	(rho)	38
⠒⠤⠒⠒⠤⠒⠒⠤⠒	σ,s	(sigma)	39
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⠒⠤⠤⠒⠒⠒⠒⠤⠤	ξ	(xi)	38
⠒⠤⠤⠒⠒⠤⠒⠤⠤	ψ	(psi)	39
⠒⠤⠒⠒⠒⠤⠒⠤⠤	ζ	(zeta)	38
⠒⠤⠤⠒⠒⠤⠒⠤⠤	χ	(chi)	39
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⠒⠤⠒⠒⠤⠒⠤⠒	ω	(omega)	39
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⠒⠤⠒⠤⠤⠒	I,II	integers	22
⠒⠒⠒⠒⠤⠤	±	(plus or minus)	4

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		(suffix sign)	18
		C complex numbers (imaginary)	21
		I integers	21
		Q rational numbers	21
		(opening of additional brackets)	7
		(opening of matrix)	7,26
		' (prime)	18
		" (double prime)	18

ALPHABETIC

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A			
|....|	absolute value of		7
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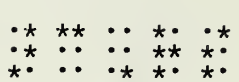
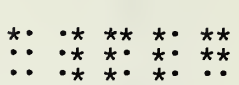
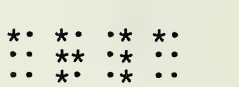
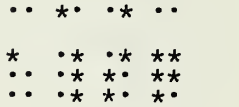
≈ ~ ≐	approximately equal to		5
	arc endpoints RS		31
	area of parallelogram		30
	area of rectangle		30
	area of square		30
	area of triangle		30
→	(arrow)		33
←	(arrow)		33
	as (used in ratios)		5
B			
	(base indicator)		11,27
	base		29
∵	because		29
	bisect		29
|....|	bracket, absolute value of		7
	bracket, additional		7

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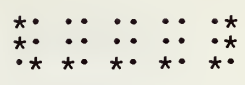
{ . . }	bracket, curly		7
(...)	bracket, round		7
[. . .]	bracket, square		7
‾‾‾	bracket, vinculum		7
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	calculus		37
¢	cent		9
	centre		30
	chord		30
O	(circle)		30
	circle		30
	circumference		30
	clearing		40
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	complete		40
	completing		40
C	complex numbers (imaginary)		21
∘	(composite function of)		21

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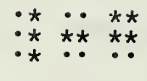
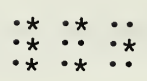
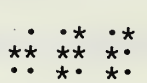
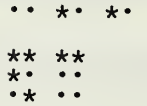
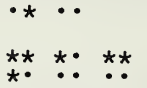
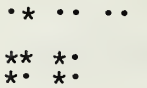
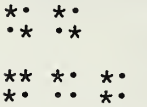
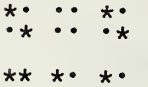
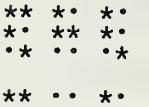
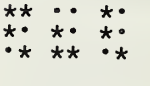
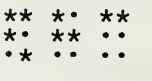
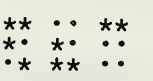
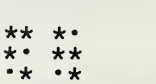
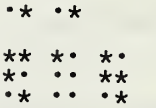
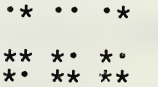
	congruent to, is		30
⊃	(contains)		21
	contains		23
cos	cosine		33
$\cos^{-1}$	arc cosine		35
cosec	cosecant		33
cosec^{-1}	arc cosecant		35
cosech			36
cosech^{-1}			36
cosh			36
$\cosh^{-1}$			36
cot	cotangent		33
$\cot^{-1}$	arc cotangent		35
coth			36
$\coth^{-1}$			36

D

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_	(decimal, repeating)		9

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°	degrees		9
Δx	delta x		33
Δy	delta y		33
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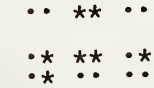
D	diameter		30
	difference between, the		11
	differentiation		37
÷ or /	(divided by)		4
÷	(divided by)		4
	divide		40
⟌	(divided into)		4
	dividing		40
⊖	division (logical)		22
$	(dollars)		9
″	(double prime)		18
E			
∈	(element of, is an)		21
∉	(element of, is not an)		21

E continued

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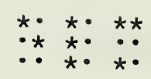
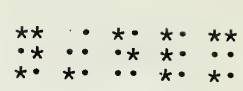
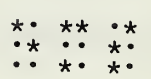
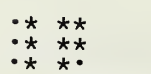
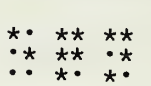
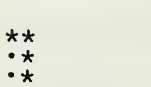
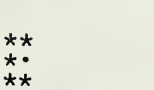
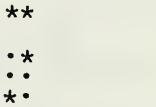
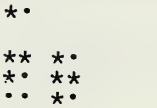
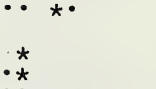
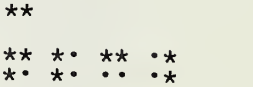
	element of set, is an		23
	element of set,is not an		23
Ø	(empty set)		21
	empty set		23
=	equals		5
	equation		40
	exponent sign		13
F			
!	(factorial)		11
/	(fraction line)		4
	fraction		40
	(fraction indicator)		3
f(x)	function of x		40
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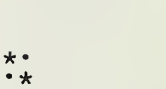
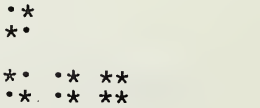
>	(greater than, is)		5
≥	(greater than or equal to, is)		5
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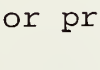
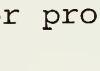
∩	(intersection or product)		21
	intersection or product		23
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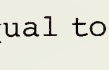
≤	less than or equal to, is		5
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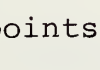
	line through points X and Y		31

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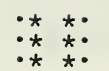
	(log)		27
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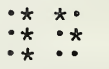
$\in$	(member of, is a)		21
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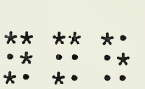
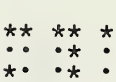
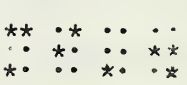
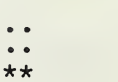
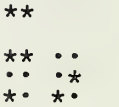
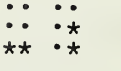
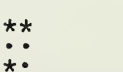
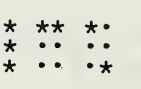
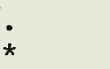
	member of set, is not a		23
	method		40
	miles		3
-	(minus)		4
	minus		29
$\mp$	(minus or plus)		4
'	minutes		9
$\otimes$	multiplication (logical)		22
x or .	multiplied by		4

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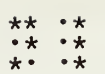
≠	not equal to, is		5
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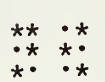
≮	not less than, is		5
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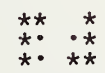
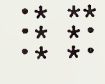
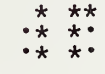
	page number		40
//	parallel		29
	parallelogram		29
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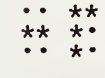
%	percent		9

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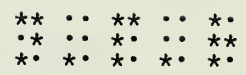
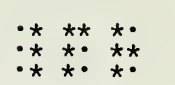
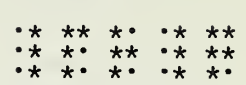
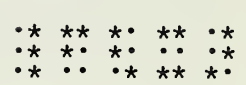
	permutations		20
⊥	perpendicular to, is		29
	perpendicular and equal to, is		30
$\phi(x)$	phi of (x)		40
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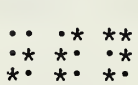
	product or intersection		23
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		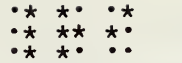	Page
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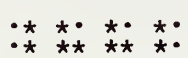
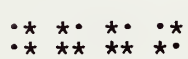
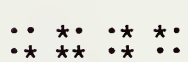
	rhomboid		29
	rhombus		29
	right angle		29
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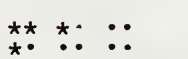
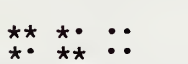
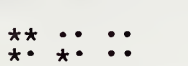
$\sec^{-1}$	arc secant		35
sech			36
sech^{-1}	arc sech		36
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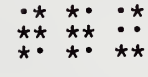
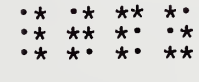
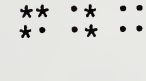
	transposing		40
	trapezium		29
∧	triangle		29

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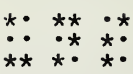
	universal set		23
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c.1

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